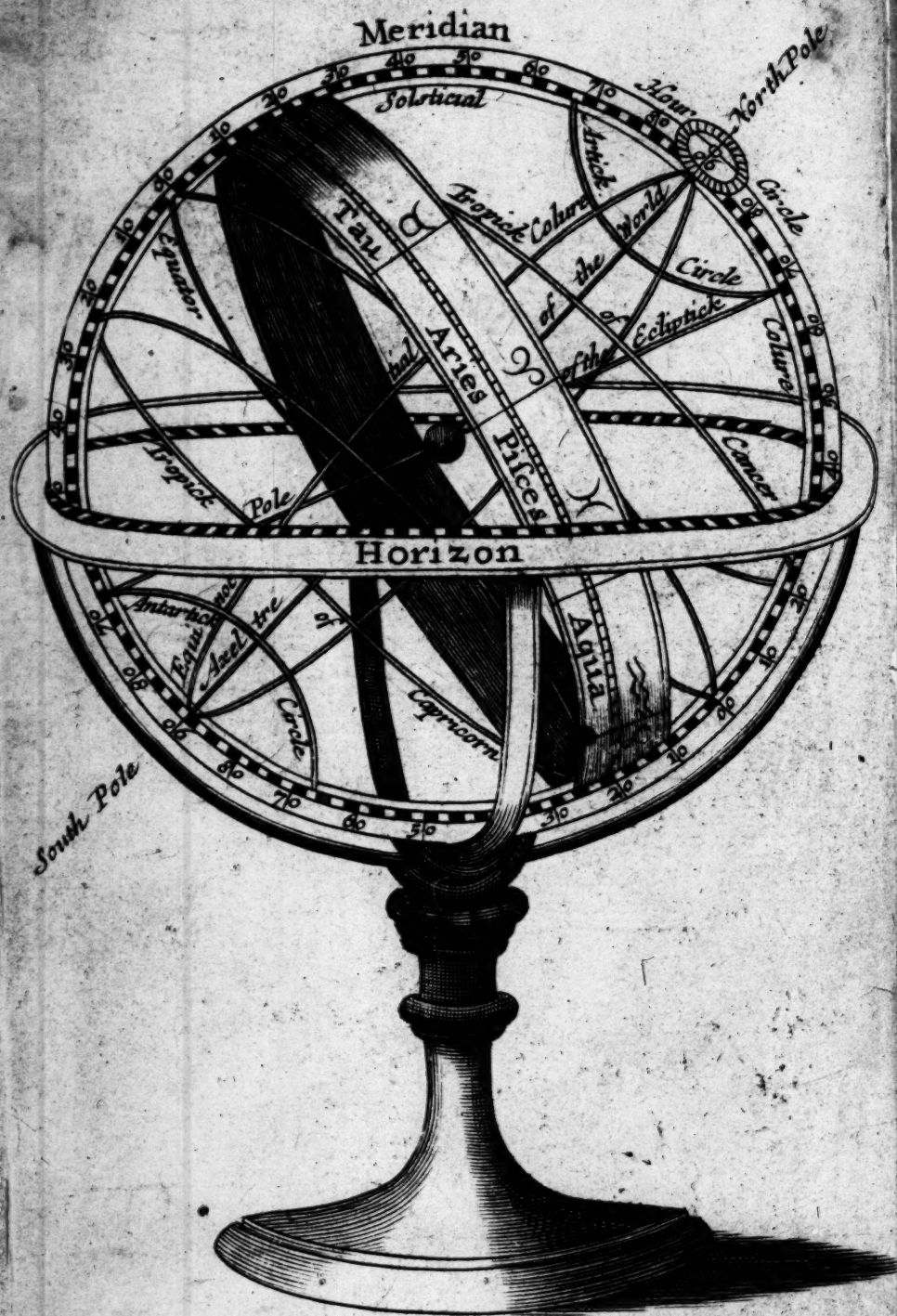
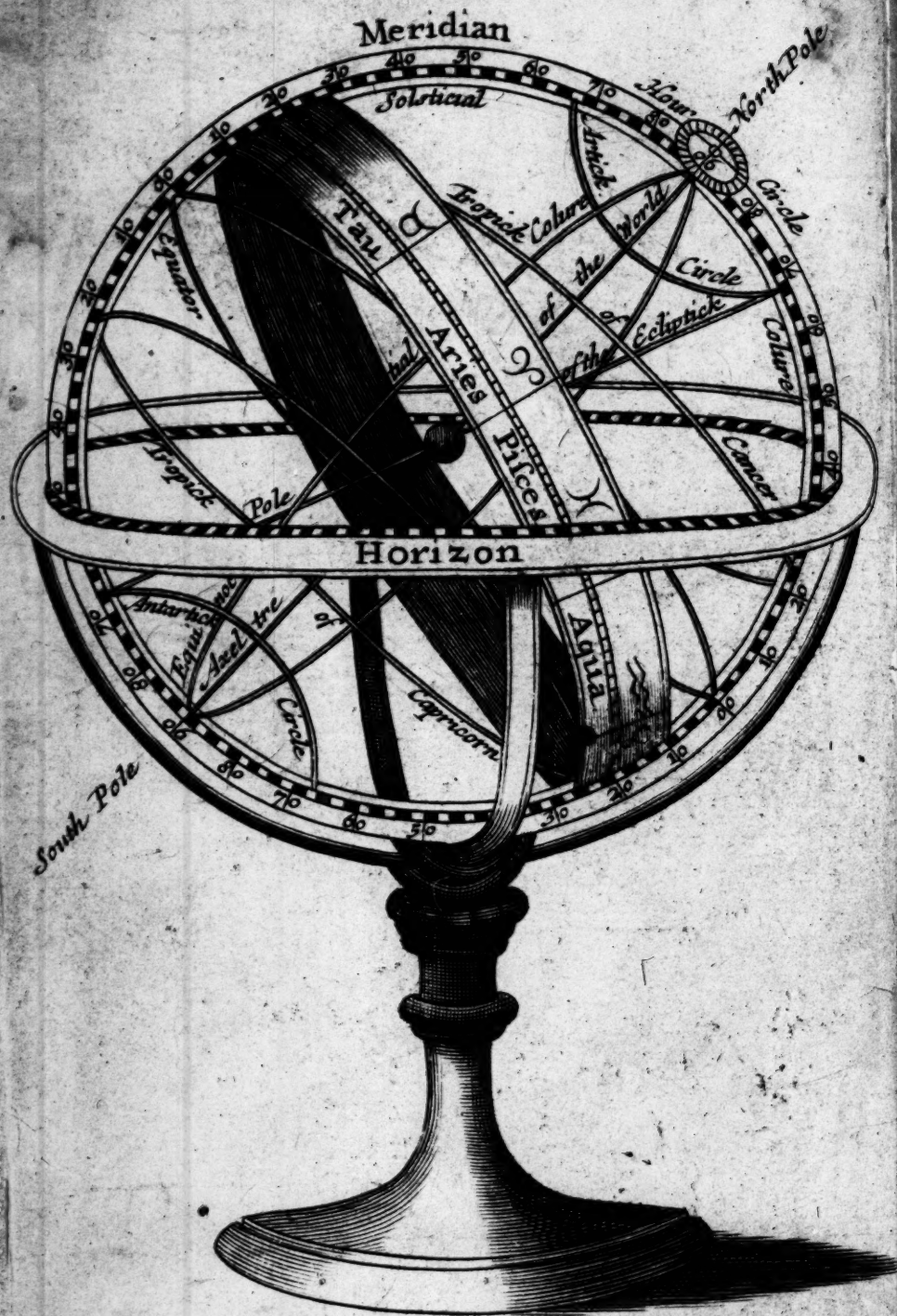






THE
Description and Uses
OF THE ~~529.6.21~~
Celestial and Terrestrial
GLOBES;
AND OF
COLLINS'S
Pocket Quadrant

By John. Harris, M. A. and F. R. S.

L O N D O N:

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March

TO THE
READER.

THIS *short Account*
of the Globe was
Originally design'd for the
Use of such Gentlemen as
learn Mathematicks of me
at Home. But the Course
of my Publick Lectures at
the Marine Coffee-House
in Birchin-Lane, obliging
me to proceed next to the

A 2

Do-

To the Reader.

*Doctrine of the Sphere ;
and the Books on this Sub-
ject already published, be-
ing much too large, and
filled with Matters very
foreign to my Design, I
thought it necessary to pub-
lish this Short Description
and Use of the Globes,
that my Auditory there may
have the Matter in a much
shorter, and yet I hope in
as plain a View: For I
know of nothing material
that is here omitted.*

The

To the Reader.

The Description and Use of Mr. Collins's Quadrant was occasioned by the Request of some Persons who would gladly know the best Uses of it, without being obliged to read over many Things which are little to their Purpose.

The Characters of the 12 Signs of the Zodiack.

<i>Aries</i>	♈	}	<i>Libra</i>	♎
<i>Taurus</i>	♉		<i>Scorpio</i>	♏
<i>Gemini</i>	♊		<i>Sagittarius</i>	♐
<i>Cancer</i>	♋	}	<i>Capricorn</i>	♑
<i>Leo</i>	♌		<i>Aquarius</i>	♒
<i>Virgo</i>	♍		<i>Pisces</i>	♓

The Characters of the Planets.

<i>Moon</i>	☾	}	<i>Mars</i>	♂
<i>Mercury</i>	☿		<i>Jupiter</i>	♃
<i>Venus</i>	♀		<i>Saturn</i>	♄
<i>Sun</i>	☼			

THE

THE
Description and Use
OF THE
GLOBES.

A GLOBE or SPHERE is a round solid Body, every part of whose Surface is equally distant from a Point within it, called its Centre; and it may be conceived to be formed by the Revolution of a Semi-circle round its Diameter.

When such a Body as this hath all the Parts of the Earth and Sea drawn or delineated on its Surface,

like as in a Map, and placed in their natural Order and Situation, it is called the *Terrestrial Globe*.

But if on its Surface it hath the fixed Stars and the Images of the Constellations drawn, together with the Circles of the Sphere, below described, 'tis then called the *Celestial Globe*.

And when the following Circles are supposed to be described on the convex Surface of a Sphere, which is hollow within, and after this you imagine all parts of the Sphere's Surface to be cut away, except those parts on which such Circles are described, then that Sphere is called an *Armillary Sphere*, because it appears in the form of several Circular Rings, or Bracelets, put together in a due Position.

There are Ten Eminent Circles upon the Globe, or of the Sphere; Six of which are called *Greater*, and the Four other *Lesser Circles*.

A

A Great Circle of the Sphere is that whose plane passeth through the Centre of the Sphere, and divides it into two equal Parts or Hemispheres.

A Lesser Circle is that which is parallel to a Greater; as the *Tropicks* and *Polar Circles* are to the *Equator*, and as the *Circles of Altitude* are to the *Horizon*.

Or Lesser Circles are such as do not divide the Globe into two equal parts.

The Greater Circles are,

1. The *Horizon*, which is a broad Wooden Circle encompassing the Globe round about, having two Notches, the one in the North, the other in the South part of it, for the Brazen *Meridian* to stand in.

There are usually accounted two *Horizons*:

First, The *Visible* or *Sensible*, which you may conceive to be made

made by some great Plain, or the Surface of the Sea ; and which divides the Heavens into two *Hemispheres*, the one above, the other (apparently) below the Level of the Earth.

This Circle determines the rising and the setting of the Sun, Moon, or Stars, in any particular Latitude ; for when any one of them come just to the Eastern edge of the *Horizon*, then we say it riseth ; and when it doth so at the Western edge, we say it setteth. And from hence also the *Altitude* of the Sun and Stars is accounted, which is their *Height* in Degrees above the *Horizon*.

2. The other *Horizon* is called the *Real* or *Rational*, and is a Circle which encompasseth the Earth exactly in the middle, and whose Poles are the *Zenith* and *Nadir* ; that is, two Points in its Axis, each 90 Degrees

grees distant from its Plain, (as the Poles of all Circles are) and the one exactly over our Heads, and the other directly under our Feet. This is the Circle which the Wooden Horizon on the Globe represents.

On which *Broad Horizon* several Circles are drawn ; the innermost of which is the Number of Degrees of the Twelve Signs of the *Zodiack*, viz. 30 to each Sign : For the Ancient Astronomers observed the Sun in his (apparent) Annual Motion, to describe always one and the same Line in the Heaven, and never to deviate from this Track or Path to the North, or South, as all the other Planets did more or less ; and because they found the Sun also to shift, as it were backward, through all the parts of this Circle or Path, so that in his whole Year's Course he would *rise, culminate, and set* with

with every point of it; they distinguished the fixed Stars that appeared in or near this Circle into Twelve Constellations or Divisions, which they called Signs; and because they were most of them usually drawn in the form of Animals, they called this Circle by the Name of the *Zodiack*, and the very middle Line of it the *Ecliptick*: And since every Circle was divided into 360 Parts or Degrees, a twelfth part of that Number must be 30, the Degrees in each Sign.

Next to this you have the Names of those Signs; next to this the Days of the Month, according to the *Julian Account*, or *Old Stile*, with the *Calender*; and then another *Calender* according to the *Foreign Account*, called the *New Stile*.

And within these is a Circle divided into Thirty two equal Parts, which make the Thirty two Rhumbs

or

(7)

or Points of the Mariner's Compass, with the first Letters of the Names annexed ; and since that one 32th part of 360 Degrees is 11 Degrees 15 Minutes, they account that each single Point of the Compass is 11 Degrees 15 Minutes.

*The Uses of this Circle on the
Globe, are*

1. To determine the Rising and Setting of the Sun, Moon, or Stars, and to shew the Time of it by the Help of the Hour-Circle and Index ; as shall be shewed hereafter.

2. To limit the Increase and Decrease of the Day and Night : For when the Sun rises due East, and sets West, the Days are equal.

But when he riseth and setteth to the North of the East and West,
the

the Days are longer than the Nights; as on the contrary the Nights are longer than the Days, when the Sun riseth and setteth to the Southward of the East and West Points of the Horizon.

3. To shew the *Amplitude* of the Sun, or of any Star, and also on what Point of the Compass it riseth and setteth.

2. The next Great Circle is the *Meridian*, which is represented by the Brazen Frame or Circle in which the Globe hangs and turns: This is divided into four Nineties, or 360 Degrees, beginning at the Equinoctial. 'Tis called the *Meridian*, because when the Sun comes to the South part of this Circle, 'tis then *Meridies*, *Mid-day*, or *High Noon*, and then the Sun hath its greatest Altitude for that Day, which therefore is called the *Meridian Altitude*.

The

The Plane of this Circle is *perpendicular* to the *Horizon*, and passeth through the South and North Points thereof, through the *Zenith* and *Nadir*, and through the Poles of the World. In it, each way from the *Equinoctial*, on the *Celestial Globe*, is accounted the North or South *Declination* of the Sun or Stars; and on the *Terrestrial*, the *Latitude* of a Place North or South; which is all one Quantity with the Elevation or the Heighth of the Pole above the Horizon, because the Distance from the *Zenith* to the *Horizon* being the same as that between the *Equinoctial* and the *Poles*, if from each you imagine the Distance from the *Pole* to the *Zenith* to be taken away, the Latitude must remain equal to the *Poles* Heighth,

There are two Points of this Circle, each 90 Degrees from the *Equinoctial*, which are called the
Poles

Poles of the World; and a Diameter from thence continued through the Centre of either *Globe*, is called the *Axis of the Earth, or Heavens*, on which they are supposed to turn round.

These *Meridians* are various, and change according to the *Longitude* of Places; for as soon as ever a Man moves but one Degree, or but a Point to the East or West, he is under a new Meridian: But there is (or should be) one *fix'd*, which is called the *First Meridian*.

And this on these Globes passes through *Gratiosa*, one of the *Azores* Islands. But the *French* place the First Meridian at *Fero*, one of the *Canary* Islands.

The Poles of the Meridian are the East and West Points of the Horizon.

On the Terrestrial Globe there are usually drawn Twenty four Meridians

ridians, one through every Fifteen Degrees of the Equator, or through every Fifteen Degrees of Longitude.

The Uses of this Circle are (first) to set the Globe to any particular Latitude, by a proper Elevation of the Pole above the Horizon of that Place : And (secondly) to shew the Sun or Stars Declination, right Ascension, and greatest Altitude ; of which more below.

3. The next Great Circle is the *Equinoctial*, as it is called on the Celestial, and *Equator* on the Terrestrial Globe. This is a great Circle, whose Poles are the Poles of the World ; it divides the Globe into two equal Parts or Hemispheres, as to North and South ; and it passeth through the East and West Points of the Horizon, and at the Meridian is always as much raised above the Horizon, as is the Com-

B

pliment

pliment of the Latitude of any particular Place. Whenever the Sun cometh to this Circle, it makes equal Days and Nights all round the Globe ; because it always riseth then due East, and sets due West; which it doth at no other Time of the Year. All Stars also, which are under this Circle, or which have no Declination, do always rise due East, and set full West.

All People living under this Circle (which in Geography, or rather by Navigators is called the Line) have the Days and Nights constantly equal ; and when the Sun is in the Equinoctial, he will be at Noon in their Zenith, or directly over their Heads, and so their erect Bodies can cast no Shadow.

From this Circle, both ways, the Sun or Stars Declination, on the Celestial, or Latitude of all Places on the Terrestrial Globe is accounted

accounted on the Meridian: And such lesser Circles as run through each Degree of Latitude or Declination parallel to the Equinoctial, are called Parallels of Latitude, or Parallels of Declination.

Through every fifteen Degrees of this Equinoctial, the Hour-Circles are drawn at right Angles to it, on the Celestial Globe, and all pass through the Poles of the World, dividing the Equinoctial into twenty four equal parts.

And the *Equator* on the Terrestrial Globe is divided by the Meridian into thirty six equal parts; which Meridians are equivalent to the Hour-Circles on the other Globe.

4. The *Zodiack* is another great Circle of the Sphere, dividing the Globe into two equal parts: When the Points of *Aries* and *Libra* are brought to the Horizon, it will cut

that and the Equinoctial obliquely, making with the former an Angle equal to the Sun's greatest Meridian Altitude in any Latitude ; and with the Equinoctial, an Angle equal to 23 Degrees and 3 Minutes, which is the Sun's greatest Declination. This Circle by Astronomers is accounted as a kind of broad one, and is like a Belt or Girdle round the Globe: Through the middle of it is drawn a Line called the *Ecliptick*, or *Via Solis*, the *Way of the Sun*; because the Sun never deviates from it, in its Annual Motion, as the Planets do all more or less, whence it hath its Breadth.

This Circle is marked with the Characters of the Twelve Signs, and on it is found out the Sun's Place; which is under what Star or Degree of any of the Twelve Zodiacal Constellations he appears to be at Noon. By this are determined

mined the Four Quarters of the Year, according as the Ecliptick is divided into four equal parts; and according as the Sun goes on here, he hath more or less Declination.

Also from this Circle the Latitude of the Planets and fixed Stars are accounted from the Ecliptick towards its Poles.

The Poles of this Circle are twenty three Degrees thirty Minutes distant from the Poles of the World, or of the Equinoctial; and by their Motion round the Poles of the World, are the Polar Circles described.

In these Poles of the Ecliptick all the Circles of Longitude which are drawn through the Zodiack, do determinate; as the *Meridians* and *Hour-Circles* do in the Poles of the World, and as the *Azimuth* or *Vertical Circles* do in the *Zenith* and *Nadir*.

5. If you imagine two great Circles passing both through the Poles of the World, and also one of them through the *Equinoctial Points*, *Aries* and *Libra*, and the other through the *Solstitial Points*, *Cancer* and *Capricorn*.

These are called the two *Colures*, the one the *Equinoctial*, the other the *Solstitial Colure*: These will divide the *Ecliptick* into four equal Parts or Quarters, which are denominated according to the Points, where these pass through, called the Four Cardinal Points; and are the first Points of *Aries*, *Libra*, *Cancer*, and *Capricorn*.

These are all the Great Circles.

6. If you suppose two Circles drawn parallel to the *Equinoctial*, at twenty three Degrees thirty Minutes distant from it, one towards the
the

the North, the other towards the South, these are called the *Tropicks*, because the Sun appears then to turn backward from his former Course, the one the Tropick of *Cancer*, and the other the Tropick of *Capricorn*, because they are under these Signs.

7. If two other Circles are supposed to be drawn through twenty three Degrees thirty Minutes, reckoned on the Meridian from the Polar Points, these are called the *Polar Circles*, the Northern is the *Artick*, and the Southern the *Antartick Circles*, because opposite to the former.

These are the Four Lesser Circles.

And these on the Terrestrial Globe the Ancients supposed to divide the Earth into Five Zones, *viz* two *Frigid*, two *Temperate*, and the *Torrid Zone*.

Besides these Ten Circles lately described, which are always drawn on the Globe its self, there are some other necessary Circles to be known, which are barely Imaginary, and supposed only to be drawn upon the Globe. As,

1. *Meridians*, or *Hour-Circles*, which are great Circles meeting all in the Poles of the World, and crossing the Equinoctial at Right Angles; these are supplied by the Meridian, Hour-Circle, and Index.

2. *Azimuths*, or *Vertical Circles*, which likewise are great Circles of the Sphere, and meet in the Zenith and Nadir, as the Meridians and Hour-Circles do in the Poles: These cut the Horizon at right Angles, and on these is reckoned the Sun's Altitude, when he is not on the Meridian. They are
repre-

represented by the Quadrant of Altitude, which being fix'd at the Zenith is movable about round the Globe through all the Points of the Compass.

3. There are also *Circles of Longitude* of the Stars and Planets, which are great Circles passing thro' the Poles of the Ecliptick, and in that Line determining the Stars or Planets Place or Longitude reckon'd from the first Point of *Aries*.

3. *Almacanters*, or *Parallels of Altitude*, are Circles having their Poles in the Zenith, and are always drawn parallel to the Horizon. These are lesser Circles of the Sphere, diminishing gradually as they are farther and farther from the Horizon.

In respect of the Stars there are also supposed to be *Parallels of Latitude*;

titude ; which are parallel to the Ecliptick, and have their Poles the same with those of that Circle.

4. *Parallels of Declination* of the Sun or Stars ; which are lesser Circles, whose Poles are the Poles of the World, and are all drawn parallel to the Equinoctial, either North or South ; and these (when drawn on the Terrestrial Globe) are called *Parallels of Latitude*.

DEFINITIONS.

1. *Latitude of any Place* is an Arch of the Meridian of that Place, intercepted between its Zenith and the Equator ; and this is the same with an Arch of the Meridian intercepted between the Pole and the Horizon ; and therefore it is often expressed by the Poles Heigth, or Eleva-

Elevation of the Pole : The Reason of which is, that from the Equator to the Pole there always being the Distance of ninety Degrees, and from the Zenith to the Horizon the same Number , and each of these ninety Degrees containing within it the Distance between the Zenith and the Pole ; that Distance therefore being taken away from both, must leave the Distance from the Zenith to the Equator equal to the Distance between the Pole and the Horizon, or to the Elevation of the Pole above the Horizon.

2. *Latitude of a Star or Planet* is an Arch of a great Circle reckoned on the Quadrant of Altitude laid through the Star and Pole of the Ecliptick, from the Ecliptick towards its Pole.

Longi-

3. *Longitude of a Place* is an Arch of the Equator, intercepted between the Meridian of the Place, and the first Meridian : Or it is more properly, the Difference, either East or West, between the Meridians of any two Places accounted on the Equator.

4. *Longitude of a Star* is an Arch of the Ecliptick, accounted from the beginning of *Aries* to the Place where the Stars Circle of Longitude crosseth the Ecliptick; so that is much the same as the Stars Place in the Ecliptick accounted from the beginning of *Aries*.

5. *Amplitude of the Sun*, or of a Star, is an Arch of the Horizon intercepted between the true East or West Points of it, and that Point upon which the Sun or Star rises or sets.

6. *Right*

6. *Right Ascension of the Sun*, or of a Star, is that part of the Equinoctial reckoned from the beginning of *Aries*, which riseth or setteth with the Sun or Star in a right Sphere; but in an oblique Sphere it is that Part or Degree of the Equinoctial which comes to the *Meridian* with it, (as before) reckoned from the beginning of *Aries*.

1. *A Right or Direct Sphere* is when the Poles are in the Horizon, and the Equator in the Zenith; the Consequence of being under such a Position of the Heavens as this, (which is the Case of those who live directly under the Line) is, that the Inhabitants have no Latitude nor Elevation of the Pole; they can nearly see both the Poles of the World: All the Stars in the Heavens do once in twenty four Hours rise, culminate, and set with them;

them ; the Sun always rises and descends at Right Angles with the Horizon, which is the Reason they have always equal Day and Night, because the Horizon doth exactly bisect the Circle of the Suns Diurnal Revolution.

2. *A Parallel Sphere* is where the Poles are in the Zenith and Nadir, and the Equinoctial in the Horizon ; which is the Case of such Persons, if any such there be, who live directly under the North or South Poles.

And the Consequences of such a Position are, That the Parallels of the Sun's Declination will also be Parallels of his Altitude, or Almucantars to them. The Inhabitants can see only such Stars as are on their side the Equinoctial ; and they must have 6 Months Day, and 6 Months continual Night every Year ; and the

the Sun can never be higher with them than 23 Degrees 30 Minutes (which is not so high as it is with us on *February 10th.*)

3. *An Oblique Sphere* is where the Pole is elevated any Number of Degrees less than 90: And consequently the Axis of the Globe can never be at Right Angles to, nor in the Horizon; and the Equator, and Parallels of Declination, will all cut the Horizon obliquely, from whence it takes its Name.

Oblique Ascension of the Sun, or Stars, is that Part or Degree of the Equinoctial reckoned from the beginning of *Aries*, which rises and sets with them in an oblique Sphere.

Ascensional Difference is the Difference between the *Right* and *Oblique Ascension*, when the Lesser is subtracted from the Greater.

On

On the Terrestrial Globe.

1. **A** Space upon the Surface of the Earth, reckoned between two Parallels to the Equator, wherein the Increase of the longest Day is a Quarter of an Hour, is by some Writers called a *Parallel*.

2. And the Space contained between two such *Parallels* is called a *Climate*: These *Climates* begin at the Equator; and when we go thence North or South, 'till the Day become Half an Hour longer than it was before, they say we are come into the *First Climate*; when the Days are an Hour longer than they are under the Equator, we are come to the *Second Climate*, &c. These *Climates* are accounted in Number 24, reckoned each way towards the Poles.
The

The Inhabitants of the Earth are divided into three sorts, as to the falling of their Shadows.

1. *Amphiscii*, who are those which inhabit the Torrid Zone, or live between the Equator and Tropicks, and consequently have the Sun twice a Year in their Zenith; at which time they are *Ascii*, i. e. have no Shadows, the Sun being vertical to them. These have their Shadows cast to the Southward, when the Sun is in the Northern Signs; and to the Northward, when the Sun is in the Southern Signs, reckoned in respect of them.

2. *Heteroscii*, who are those whose Shadows fall but one way; as is the Case of all such as live between the Tropicks and Polar Circles: For their Shadows at Noon are always

C to

to the Northward in North Latitude, and to the Southward in South Latitude.

3. *Periscii*, are such Persons that inhabit those Places of the Earth that lie between the Polar Circles and the Poles, and therefore have their Shadows falling all manner of ways, because the Sun at some times of the Year goes clear round about them.

The Inhabitants of the Earth, in respect of one another, are also divided into three sorts.

1. *Periaci*, who are such as inhabiting the same Parallel (not a Great Circle) are yet directly opposite to one another; the one being East or West from the other exactly 180 Degrees, which is their Difference of Longitude: Now these

these have the same Latitude and Length of Days and Nights, but exactly at contrary Times; for when the Sun riseth to the one, it sets to the other.

2. *Anteci*, who are Inhabitants of such Places as being under a Semicircle of the same *Meridian* do lie at equal Distances from the Equator; one towards the North, and the other towards the South.

Now these have the same Degree of Latitude, but towards contrary Parts, the one North and the other South; and therefore must have the Seasons of the Year directly at contrary times one to the other.

3. *Antipodes*, who are such as dwell under the same Meridian, but in two opposite and equidistant Parallels, and in the two opposite Points of those two Parallels; so that they go

to the Northward in North Latitude, and to the Southward in South Latitude.

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Now these have the same Degree of Latitude, but towards contrary Parts, the one North and the other South; and therefore must have the Seasons of the Year directly at contrary times one to the other.

3. *Antipodes*, who are such as dwell under the same Meridian, but in two opposite and equidistant Parallels, and in the two opposite Points of those two Parallels; so that they go

(30)

Feet against Feet, and are distant from each other an entire Diameter of the Earth, or 180 Degrees of a Great Circle.

These have the same Degree of Latitude, but the one South, the other North, and accounted from the Equator a quite contrary way; and therefore these will have all things, as Day and Night, Summer and Winter, directly contrary to one another.

P R O B L E M S.

I. To find the Latitude of any Place,

Bring the Place to the Brass Meridian, and the Degrees of that Circle intercepted between the Place and the Equinoctial are the Latitude of that Place either North or South.

Then to fit the Globe so that the Wooden Horizon shall represent the Ho-

Horizon of that Place, elevate the Pole as many Degrees above the Wooden Horizon, as are the Latitude of that Place, and it is done; for then will that Place be in the Zenith.

If after this you rectifie the Globe to any particular Time, you may by the Index know the Time of Sun-rising and setting with the Inhabitants of that Place, and consequently the present Length of their Day and Night, &c.

2. *To find the Longitude of Places,*

Bring the Places severally to the Brass Meridian, and then the Number of Degrees of the Equinoctial which are between the Meridians of each Place, are their *Difference of Longitude* either East or West.

But if you reckon it from any Place where a First Meridian is sup-

posed to be placed, you must bring that First Meridian to the Brazen one on the Globe; and then turning the Globe about, till the other Place come thither also, reckon the Number of Degrees of the Equinoctial, intercepted between that First Meridian, and the proper one of the Place, and that is the Longitude of that Place, either East or West.

3. *For the Distances of Places on the Terrestrial Globe,*

See the Problem on the Celestial Globe, *For finding the Distance between two Stars.*

4. *To*

4. To find what Places of the Earth the Sun is vertical to at any Time assigned,

Bring the Sun's Place found in the Ecliptick on the Terrestrial Globe to the Brazen Meridian, and note what Degree of the Meridian it cuts; then by turning the Globe round about, you will see what Places of the Earth are in that Parallel of Declination, (for they will all come successively to that Degree of the Brazen Meridian) and those are the Places or Parts of the Earth to which the Sun will be vertical that Day; whose Inhabitants will then be *Ascii*, that is, their erect Bodies at Noon will cast no Shadow.

PROBLEMS on the *Celestial Globe.*

Suppose *May* the 10th, 1701,
the Sun's Place to be just at
the entrance into the first Degree
of *Gemini* :

1. *To Rectifie the Globe,*

Or to render it in the General fit
to resolve any Problem ; which *Rec-*
tification therefore is always suppo-
sed to be the first thing done. To
do which,

Bring the Sun's Place, found in
the Ecliptick on the Globe, to the
Meridian, and the Hour-Index to
12 at Noon.

2. *For the Sun's Declination,*

Bring the Sun's Place for that
Day (which here and below is sup-
posed

posed to be given) to the *Meridian* as before, and then the Degrees of the *Meridian* reckoned from the Equinoctial either *North* or *South*, are the Sun's *Declination* at Noon, either *North* or *South*, according to the Time of the Year, *viz.* from *March* the 10th to *September* the 12th *North*; and thence to *March* again *South*: and the *Declination* for *May* the 10th will be 20 Degrees, and about 12 Minutes *North*.

3. For his *Amplitude*, either rising or setting,

Bring the Sun's Place to the Horizon, either on the East or West side, and the Degrees of the Horizon accounted from the East Point, either *North* or *South*, are the *Amplitude* required; *viz.* *May* the 10th, the Sun's *Amplitude*, will be 34 Degrees to the *North* of the East.

And

And at the same time you have in the outer Circle of Rhumbs the Point which the Sun rises or sets upon; viz. N. E. by E. or N. W. by W.

4. *For his Right Ascension,*

Bring the Sun's Place to the *Meridian*, and the Number of Degrees intercepted between the Beginning of *Aries*, and that Degree of the Equinoctial which comes to the *Meridian* with the Sun, is the *Right Ascension*.

If you would have it in Time, account every 15 Degrees to be an Hour, and every Degree to be 4 Minutes.

N. B. The Reason of bringing the Sun's Place to the *Meridian* in this Problem is, to save the Trouble of putting the Globe into the Position of a *Right Sphere*: For properly, Right Ascension is that Degree

gree of the Equinoctial which rises with the Sun in a *Right Sphere*. But since the Equator is always at Right Angles to the *Meridian*; if you bring the Sun's Place thither, it must in the Equinoctial cut his Right Ascension. Thus in the Instance of *May* the 10th, the Sun's Right Ascension will be 59 Degrees, or 4 Hours wanting 4 Minutes.

5. *For the Oblique Ascension,*

Bring the Sun's Place to the *Horizon* on the East side, and the Number of Degrees intercepted between that Degree of the Equinoctial which is now come to the *Horizon*, and the Beginning or first point of *Aries*, is the *Oblique Ascension*. Thus *May* the 10th the Sun's *Oblique Ascension* is 30 Degrees 15 Minutes.

Of these two *Ascensions*, take the Lesser from the Greater, the Remainder will be

6. *The*

6. *The Ascensional Difference:*

Which therefore is the Difference in Degrees between the Right and Oblique Ascension, or the Space between the Sun's Rising and Setting, and the Hour of Six: Wherefore his Ascensional Difference turned into Time, will give the Time of the Sun's Rising or Setting before or after Six. Thus from 59 degrees take 30 degrees 15 minutes, there will remain 28 degrees 45 minutes; the *Ascensional Difference* in Degrees, and in Time 1 hour 55 minutes; and so much doth the Sun rise before 6, and set after it.

7. *For the Sun's Rising or Setting,*

Bring his Place to the *Horizon*, either East or West, and the Hour-Index shall shew the Time either of his Rising or Setting accordingly; which, *May* the 10th, is 5 minutes
after

after 4 in the Morning, and 5 minutes before 8 at Night.

The Time of the Sun's Setting, doubled, gives the Length of the Day, which then will be 15 hours 50 minutes ; and the Time of this Rising doubled, gives the Length of the Night ; which *May* the 10th is 8 hours 10 minutes.

8. *For the Sun's Meridian Altitude, or Depressi^on at Midnight,*

Bring his Place to the *Meridian*, above the *Horizon*, for his Noon Altitude, which will shew the Degrees of it accounted there from the *Horizon* ; which *May* the 10th will be 58 degrees 42 minutes. For his Midnight Depressi^on, below the North Point of the *Horizon*, you must bring the Point in the Ecliptick opposite to the Sun's present place, to the South part of the *Meridian* above the *Horizon* ; and the
Degrees

Degrees there intercepted between that Point and the Horizon, are his Midnight Depression; which May the 10th will be 18 deg. 42 min.

9. *For the Sun's Altitude at any Time of the Day given,*

Rectifie the Globe, and *fit the Quadrant of Altitude*, that is, serue the Brass Quadrant of Altitude to the Zenith; or in our Latitude, serue it so that the graduated Edge cut 51 deg. 30 min. on the Meridian, reckoned from the Equinoctial.

Then turn about the Globe till the Index shew the Time proposed, and stay the Globe there; after which bring the Quadrant of Altitude to cut the Sun's place in the Ecliptick, and then that Place or Degree of the Ecliptick shall shew the Sun's Altitude on the Quadrant.

Thus

Thus *May* the 10th, the Sun's Altitude at 9 a Clock in the Morning will be 43 degrees, 30 minutes.

10. *To find the Sun's Hour or Altitude, when he is due East or West, above the Horizon.*

Rectifie the Globe, and fit the Quadrant of Altitude, then bring the Quadrant to cut the true East Point, and next turn the Globe about till the Sun's place in the Ecliptick cut the graduated Edge of the Quadrant; for then that Place will shew the Altitude, and the Index the Hour.

Thus *May* the 10th the Sun will be East at 5 minutes past 7 in the morning, and his Altitude then is 26 degrees.

11. *To*

11. *To find the Sun's Altitude, or the Time of the Day, on any Azimuth given; Or when the Sun is on any given Point of the Compass.*

Set the Quadrant of Altitude to the Azimuth given, then turn the Globe till his place in the Ecliptick touch the graduated Edge of the Quadrant; so shall *that* Place give the Altitude on the Quadrant, and the Hour-Index the Time of the Day.

Example. May the 10th, the Azimuth being 60 degrees from the South, toward the East, or the Point of the Compass which the Sun is then on, being S. E. by E. and near half a Point more Easterly; his Altitude will be (nearly) 46 degrees, and the hour of the Day a little more than a quarter past 9 in the morning.

12. *To find the Declination and Right Ascension of any Star.*

Bring the Star to the *Meridian*, and then the Degrees intercepted between the *Equinoctial* and the Point of the *Meridian* cut by the Star, are its *Declination*; and the *Meridian* cuts and shews its *Right Ascension* on the *Equinoctial*, accounting it from the Beginning of *Aries*.

13. *To find the Longitude and Latitude of any Star.*

Bring the *Solstitial Colure* to the *Brass Meridian*, and there fix the *Globe*; then will the *Pole* of the *Ecliptick* be just under 23 d. 30 m. accounted from the *Pole* above the *North Point* of the *Horizon*, and upon the same *Meridian*; there skrew the *Quadrant of Altitude*, and then bring its graduated *Edge* to the *Star* assigned, and there stay
D it,

it, so will the Star cut its proper *Latitude* on the *Quadrant*, reckoned from the *Ecliptick*; and the *Quadrant* will cut the *Ecliptick* in the Stars *Longitude*, or its Distance from the first Point of *Aries*.

14. To find the Time of any Star's *Rising, Setting, or Culminating* (i. e.) *being on the Meridian*.

Rectifie the Globe and Hour-Index, and bring the Star to the East or West part of the *Horizon*, or to the *Brazen Meridian*, and the *Index* will shew accordingly the Time of the Stars *rising, setting, or culminating*, or of its being on the *Meridian*.

Thus *May* the 10th, *Arcturus* will be on the *Meridian* at about $\frac{1}{4}$ of an hour after 10 at Night, *Cor Leonis* will be *setting* about one in the Morning, and the first Star in the Head of *Aries* will be *rising* about an hour after.

15. To

15. To know at any Time assigned what Stars are Rising or Setting; what are on the Meridian; and how high they are above the Horizon; and on what Azimuth or Point of the Compass they are; by which means the real Stars in the Heaven may easily be known by their proper Names, and rightly distinguished one from another.

Rectifie the Globe, and fit the Quadrant of Altitude, and set the Globe, by the means of the Compass, due North and South; then turn the Globe and Hour-Index to the hour of the Night assigned, so will the Globe thus fix'd, represent the face or appearance of the Heavens for that Time.

Whereby you may readily see what Stars are in or near the Horizon, what are on or near the Meridian; which are to the North, or

which to the South, &c. And the Quadrant of Altitude being laid over any particular Star, will shew its *Altitude* and *Azimuth*, and on what Point of the Compass it is; whereby any Star may be easily known; especially if you have a Quadrant, or any such Instrument, to take the Altitude of any real Star, supposed to be known, by the Globe; to see whether it agree with that Star which is its Representative on the Globe or not.

16. *Given the Sun's Place, and any Star's Altitude, to find the Hour of the Night.*

Rectifie the Globe, and fit the Quadrant; then move the Globe to and fro, till the Quadrant cut the Star in its given Altitude; for then the Hour-Index will shew the Hour of the Night. And thus may the Hour of the Night be known by a Star's Azimuth,

Azimuth, or its Azimuth from its Altitude.

Example. May the 10th, the Sun being in the first degree of *Gemini*, I take the Altitude of *Lucida Lyra*, which I find to be 51 degrees, or I find its *Azimuth* to be two degrees to the Northward of the East; then bringing to the Quadrant of Altitude, to cut that Star in 51 degrees of *Altitude*, I find the Hour-Index points at 11 a Clock at Night; as it would also have done, had the Star been brought to the Azimuth on the Globe.

17. *To find the Distance between any two Stars.*

If the Stars lie both under the same Meridian, bring them to the Brazen Meridian, and the Degrees between them *there* reckoned are their true Distance.

Thus *Capella*, or the Star in the Left Shoulder of *Auriga*, and *Rigel*, which is in *Orion's* Left Thigh, are nearly under the same Meridian; and being both brought to the Brazen Meridian of the Globe, their Distance there will be found to be 54 degrees.

If they are both in the Equinoctial, or have both the same Declination, (*i. e.*) are both in the same Parallel, then bring them one after another to the Brazen Meridian, and the Degrees of the Equinoctial intercepted between them, when thus brought to the Meridian severally, are their Distance.

If the Stars are neither under the same Meridian nor Parallel, then either lay the Quadrant of Altitude from one to the other, (if it will reach) and that will shew the Distance between them in Degrees: Or else take the Distance with Compasses,

passes, and apply that to the Equinoctial, or to the Meridian.

Which Method of Proceeding also will shew the Distance of any two Places on the Terrestrial Globe in Degrees; and by Multiplication by 70, you will have it in Miles. Wherefore to find how far any Place on the Globe is from another, you need only take the Distance between them on the Globe with a pair of Compasses; and applying the Compasses to the Equator, at the Beginning of *Aries*, or at the first Meridian, you will there find the Degrees; which multiply by 70, and that will turn it into Miles.

Thus the Distance between *London* and *Jamaica* being on the Globe 69 Degrees; I multiply that by 70, and it gives me 4830 Miles; and so far is *Jamaica* distant *directly* from *London*, or in an Ark of a Great Circle.

(88)

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THE
Description and Use
OF
COLLINS'S
Pocket Quadrant.

ON the Right Edge from the Centre is a Scale of Equal Parts, as useful as other such Scales : 'Tis five Inches in Length, and divided into 100 equal parts.

On the Left Edge is a Line of Tangents continued to two *Radii*, or to 63 degrees 23 minutes, whose *Radius* is two Inches and half ; and lying by these are a Line of Hours and Latitudes for Dyalling.

Be-

Between these two is the Projection ; which is only a quarter of *Stoffler's Asholabe* inverted, and fitted for the Latitude of *London*.

Above the Projection, towards the Centre, is put on in a Quadrant of a Circle, the Sun's Declination. This is easily found, being next under the Circles of the Days of the Months: And above this, in four other Quadrants, are the Days of the Months, according to the four Seasons of the Year.

Below the Projection is the Quadrant and Line of Shadows; and next below that is the Limb, divided into Degrees and Time.

In the Projection are drawn the two Eclipticks, easily known by the Characters of the Signs, and both issuing out from the Point of 50 degrees 30 minutes in the Tangent Line on the Left Edge; and also the two Horizons coming from the same

same Point, and running as the Eclipticks do, one upward, the other downward.

And beside these, all Lines that run from the Right Hand of the Quadrant (reckoned from the Centre), towards the Left, are Parallels of Altitude; these begin at the Winter or Upper Horizon, and run down to 62 degrees, and run up to 18 degrees; but those that cross them, and run the other way, are all Azimuths.

Such eminent Stars as are between the two Tropicks, are placed upon the Projection, with Letters to them, referring to their Names on the Back part, where also their Declinations are placed, and their Right Ascensions are found in the Limb.

I omit the Description of the Back-part, as being of little use; but those which have *Collins's Sector* on a *Quadrant* may find a large Account of it there. Be-

Below the Projection is the Quadrant and Line of Shadows, which is only a Line of Natural Tangents to the Arks of the Limb.

All the Parts of the Quadrant are to be esteemed as less than *Radius*, till you come right over 45 degrees of the Limb, and there you will see the Number 1. Then begin the Shadows, and where you see the Figures 1, 2, 3, 4, 5, &c. you are to understand by them so many *Radii*; and because 'tis sometimes of use to have these repeated, towards the Left Hand in the Quadrant, there are great Black Points set to represent them.

The

The Uses of the Quadrant.

1. *To Rectifie the Bead.*

Lay the Thread over the Day of the Month, and if it be in the Winter Half Year, bring the Bead to the Upper Ecliptick; but if it be Summer, to the Lower Ecliptick, and then the Quadrant is fitted for use. Only observe, that if even in Summer you would find the Sun's Hour and Azimuth before or after six a Clock in the Morning or Evening, the Bead must be rectified to the Winter Ecliptick; and you must use those Parallels that are above the Winter Horizon in the reverted Tail, as *Collins* calls it. And the String lying thus, shews all these things at once.

1. The

1. The *Sun's Declination* in its proper Circle, next under the Circles of the Months; which from *March* the 10th to *September* the 12th will be North, but the rest of the Year South.

2. The *Sun's Place* in the Ecliptick, according to the Season of the Year.

3. His *Right Ascension* in Time, and Degrees, in the Limb. Only as to this you must remember to account it from the Left Edge towards the Right in the Spring-time, because the Sun is then moving towards the Tropick; but when the Sun is past the Tropick, and is coming back again, it must be accounted the contrary way, from the Right toward the Left: And besides this,

From

From	June 11. to Sep. 13.	} you must add	90	} Degrees to the Sun's Right Ascension found in the Limb:
	Sept. 13. to Dec. 11.		180	
	Dec. 11. to March 10.		270	

2. *To observe the Sun's Height or Altitude,*

Turn your Back to the Sun, and let his Rays shine through the Upper Sight on the Back Hole in the Lower; and then the Thread playing freely in the Limb, will shew the Altitude *there*, to be accounted from the Left towards the Right Hand, according to the Directions above given.

3. *Having the Sun's Altitude, To find the Hour of the Day, and the Sun's Azimuth,*

Rectifie the Bead, and move the String about till the Bead fall among the Parallels of Altitude in the Projection.

jection, on *that* which expresses the Altitude observed ; and then shall the String shew the Hour in the Limb to a Minute : And the Bead will shew the Sun's Azimuth also at that Time of the Day.

Also if the String be laid to any Hour in the Limb, and the Bead rectified, it will shew the Sun's Altitude and Azimuth belonging to that Hour, if it be before six at Night, or after six in the Morning. But if you would know his Altitude for any time before or after six in the Summer-time, you must rectifie the Bead to the Winter-Ecliptick, and then it will fall on the true Parallel of Altitude for that Hour. 'Tis the same for the Azimuth.

4. *To find the Sun's Amplitude,*

Rectifie the Bead according to the Time of the Year, to its proper Ecliptick; and then bring it to that Horizon it will cut, and the Bead there will shew the Amplitude.

In the Summer Half Year you must reckon the Amplitude from East or West, Northward; but in the Winter six Months, from thence Southward. The same is done for any Star in the Projection, by rectifying the Bead to the Star, and then bringing it to the Horizon it will come to touch; and if the Star have North Declination, his Amplitude will be North; if South, the contrary.

5. *For the Sun's Rising or Setting,*

Bring the Bead rectified to the proper Hori-zon, as before, and the
E
String

String in the Limb will cut the Time *there* that the Sun riseth before or after fix.

N.B. This is the Ascensional Difference, and may be reckoned either in Degrees or Time.

If you double the Sun's setting, it gives the Length of the Day; if you double the Time of the Night.

The Use of the Quadrant and Shadows.

1. *To find an Height at one Station,*

Look through the Sights at the top of the Tower, Steeple, &c. and letting the String play freely in the Limb, observe where it rests; when you have a good Sight of the top of the Height you would measure: For if the String fall just on Number 1 in the Quadrant, the Height of the Object

Object above the Level of the Eye is just equal to the Perpendicular or nearest Distance of the Eye from the Tower. Measure then from the Place of the Station to the Tower, and adding to that the Heighth of the Eye above the Ground, the Sum is the Tower's Heighth in Yards, Feet, &c.

But if being nearer the Tower you had found the String to fall on 2, 3, or 4, of the Shadows towards the Right Hand, &c. you are then to conclude the Tower is accordingly twice, thrice, or four times as high above the Level of the Observer's Eye, as is the nearest Distance from him to the foot of the Tower.

On the Contrary, if going farther from the Tower you should find the String to fall on the second, third, or fourth Black Point in the Quadrat toward the Left Hand; you

are then to judge, that the Distance between you and the Tower is twice, three times, or four times as great as the Height of the Tower above the Eye.

For it will always be thus; as *Radi-
us* is to the Tangent of the Angle of the Altitude at the Place of Observation, (*i. e.* to the Parts cut in the Quadrant or Shadows) so is the Distance between the Station and the Foot of the Object, to the Height of the Object above the Eye.

Which Canon worked by the Tables, will readily give the Height of any Object in such Measures as the Distance between the Station and the Foot of the Object are taken in, let the Angle of Altitude be gained by any Instrument whatsoever.

F I N I S.

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